From NEMO Network to Regional Growth Core:

By Mario Spiewack

"Fluss-Strom" Is Harnessing Hydropower

Propeller, turbine or water wheel: the researchers want to know how to maximize efficiency.

Photo: Fraunhofer IFF

The idea of harnessing the power of running water has fascinated sharp minds for many years. Unlike that from windmills, the mechanical energy from rivers was already viewed as reliable energy earlier, something highly valued in the energy transition today. Whereas wind delivers good yields on fewer than half of all days and solar power fluctuates depending on the transition from day to night, cloud cover and seasons, rivers only rarely carry so little water that they entirely run dry as an energy source. Now it appear as if rivers' flow force is bound to experience a revival, too.

A replica of a historic ship mill stands on the left bank of the Elbe in the middle of Magdeburg. This energy source and a number just like it floated firmly anchored on the river until the start of the last century and took advantage of the river current. At a medium water level, the current still surges toward Hamburg at around 1.7 meters per second. Theoretically, the area from the German border to the river's mouth would suffice to erect 150 000 such approximately ten-meter-long floating energy sources.

Ship Mills: A Nearly Forgotten Form of Energy Production

Ship mills, which were reliable machines throughout the Middle Ages, have long since disappeared from public consciousness since their removal because they were obstacles to shipping and, not least, also because they only used mechanical energy. The electrical grid producing cheap power from coal, which rapidly expanded around 1900, was this technology's death knell.

Today, major run-of-the-river hydroelectric power plants such as the Rheinkraftwerk in Iffezheimhere are located where ship or river mills once characterized the appearance of many flowing waters from the sixth century onward. These plants constitute a major intrusion in the particular flowing waters and are usually connected with the need to dam up that body of water. High-tech hydroelectric power plants with turbine units have replaced earlier ship mills with the most basic elements of a floating platform and an undershot water wheel. Such large power plants can, however, be built only after a time consuming permit process and only at select suitable locations.

This nearly forgotten form of energy production with small mobile hydroelectric power plants such as ship mills represents a considerable potential as energy prices steady mount and increased percentages of renewables gain prestige.

Producing Electricity from Flowing Waters

This potential prompted the formation of a collaborative partnership, the NEMO network, in Magdeburg in 2008. Its mission is to produce electricity from flowing waters. The engineers decided the plants should be mobile. They should be mass producible, have maximum efficiency, and be fully operational when transported to their sites of operation. The experts additionally the environmental impact of the slow-running water wheels a priority. The small hydroelectric power plants should not disturb fish.

The small hydroelectric power plants are modularly designed technological solutions and products. The main plant components are the floating platform, a transformer, a debris deflector, and generator and control systems. Different prototype have been built in the network's individual projects in recent years.

Prototype Field Trials

One of them, called VECTOR, was produced in a partnership between the Fraunhofer Institute for Factory Operation and Automation IFF and Sibau Genthin GmbH. This floating and mobile plant is in active use on the Elbe in Magdeburg and the Elbe-Havel Canal in Genthin to continuously test the flow transformer and all kinds of peripherals.

The Fraunhofer researchers and their partners tested different manufacturers' turbines and wheels and created first mathematically models from the measured data. New blade materials, advanced turbines, and, above all, the conversion of flow energy into electricity have given rise to entirely new demands on the design and use of run-of-the-river hydroelectric power plants. For instance, very lightweight fiber-reinforced aluminum foam propellers are being used. The river's power above a current velocity of approximately 1.5 meters per second suffices to produce 1 to 4 kW or more of power with a small turbine with a diameter of approximately 80 cm, depending on its design. Several systems in combination can deliver over 30 kW of power even in tight space.

The VECTOR is currently on the banks of the Elbe-Havel Canal at SIBAU Genthin GmbH in Genthin, its owner and the project partner. It has been equipped with a more powerful drive unit. "This enables VECTOR to reach a speed of up to seven knots," says CEO Heinrich Baumgärtel. "Now we can freely simulate the flow velocity of bodies of water – a significant advantage for the tests," explains his project partner Frank Mewes from the Fraunhofer Institute in Magdeburg.

For about two years, the widest variety of systems have been being attached to the catamaran and then tested. The data obtained have been analyzed for the particular manufacturer. The initial goal was optimized machinery with yields that could generally be improved by one to two percentage points. The increase in the efficiency of newly developed water wheels and turbines is significantly higher. The data provide basic knowledge, too. Experience, partly because so few small power plants are in use worldwide, and assured measured values have both been lacking. What turbine propeller geometries and what materials prove best at which current velocities? Robustness and running expenses determine whether such plants and especially micro power plants that produce just a few kilowatts of power will be cost effective later. The RIVER RIDER, the first floating micro hydroelectric power plant, lies in the outlet of Wendefurth Dam. It was developed by the partners in the Technologiekompetenz Fluss-Strom network and implemented by BÄNECKE Industrieservice und Wasserkraft and generates base load power.

The River Rider Tandem in Forst, Neisse.

The Innovative Regional Growth Core Program

is a funding action of the Federal Ministry of Education and Research that is part of its Entrepreneurial Regions innovation initiative for new German states. It is intended to inspire developments with major economic potential in the new German states. Usually, such economic potential is only fully exploitable when several regional companies' develop complementary products or systems.

The RIVER RIDER Tandem is located on the Rhine near Niederheimbach in Rhineland Palatinate.

Mainzer Stiftung für Klimaschutz und Energieeffizienz, Stadtwerke Mainz, Enertainer Energy GmbH and MAINOVA AG refined the principle of ship mill energy production. The result is the RIVER RIDER Tandem now installed on the Rhine near Niederheimbach. This ship mill is specially designed for run-of-the-river hydroelectricity and does not need any barrages. Anchored in the water, it generates up to 8 kW of power continuously. This type of plant has a large range of uses and generally does not disturb nature. The two undershot water wheels with connected generators convert the Rhine's flow energy into power.

Methods and assessment systems that reduce the time and labor required to verify a positive environmental impact will be developed together with network partners next year in order to make the complex permit process required by water and environmental agencies somewhat easier. To this end, underwater camera systems will be developed, which will show whether turbines disturb fish. The cable connection for the transport of power to land and simple but dependable integration in the local grid will also be refined for maximum cost effectiveness in the coming months.

From NEMO Network to Regional Growth Core through an Innovation Forum

The Technologiekompetenz Fluss-Strom NEMO network of companies, small businesses and research organizations was established over three years ago in order to make the river power usable without any negative environmental impact. The network has grown to thirty-four members.

The Technologiekompetenz Fluss-Strom network has received the State of Saxony Anhalt's Environmental Alliance's Climate Mitigation Award (2012), the Hugo Junkers Award (2013) and the Capital City of Magdeburg's Environmental Award (2013) for technological developments in environmentally compatible run-of-the-river hydroelectricity.

The Fluss-Strom PLUS Innovation Forum arose in the wake of the Renewable Energy Act and ensuing requirements to increase the percentage of power produced from renewables.

Network and development work and the Innovation Forum's results have motivated the network partners to build upon the regional growth core Fluss-Strom PLUS, an alliance of seventeen companies and seven research organizations, including the Fraunhofer IFF in Magdeburg.

Funded by the partners, the Technologiekompetenz Fluss-Strom network of companies and research organizations intends for the envisioned growth core to use cost efficient and environmentally friendly hydroelectric power plants, especially for freely flowing waters, to develop energy sites with low hydropower potential. The challenge will be finding the right solution for a particular hydropower site in the future.

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